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Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices

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Abstract An oft-cited maxim in higher education is that "faculty teach the way they were taught" because they receive little formal training in teaching before entering the classroom. However, little is known about the origins of faculty knowledge about teaching or the role their prior experiences play in the development of their teaching practices. In this exploratory study, we interviewed and observed 53 science, technology, engineering, and mathematics faculty at three research institutions. Using qualitative analysis methods (i.e., thematic and causal network analysis), we find that faculty do not only model their teaching after previous instructors, but also draw upon a varied repertoire of knowledge and prior experiences. These include knowledge derived from their experiences as instructors (46 respondents), their experiences as students (22 respondents), their experiences as researchers (9 respondents), and from their non-academic roles (10 respondents). In-depth analyses of two faculty members elaborate on the relationship between these varied types of prior experiences and how they interact with other factors including beliefs about teaching, instructional goals, and features of the organizational context to ultimately shape their classroom practice. The results suggest that instead of assuming that faculty lack any knowledge about teaching and learning, professional developers and policymakers should instead acknowledge and build upon their preexisting "craft" knowledge as professional teachers. Future research should focus on relationships between specific types of knowledge and teaching practice and how these varied experiences influence identity formation.

Keywords Undergraduate instruction · Prior experiences · College faculty · Faculty teaching · Teaching practices · Knowledge base

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Introduction

An oft-repeated mantra in higher education is that faculty[1] "teach the way they were taught," a statement acknowledging that few actually receive formal instruction in how to teach during their graduate training. Implicit within this commonly held view is that faculty generally lack sophisticated views regarding pedagogy and learning theory (Halpern and Hakel 2003) and that their teaching simply replicates that of their mentors (e.g., Mazur 2009). However, this perspective is limited: the claim about faculty teaching the way they were taught has little basis in empirical evidence; it assumes a causal and linear relationship between past experience and behavior, and it overlooks other sources of professional knowledge and expertise that may influence teaching. This latter point is particularly important because research demonstrates that teachers' professional identities are influenced by many factors including their knowledge of the subject matter, social and political context, family influences, and especially the knowledge that they develop over time about how to teach particular topics (i.e., pedagogical content knowledge) (Shulman 1986; Beijaard et al. 2004). Further, evidence suggests that even if faculty teaching was solely informed by their mentors' behavior, no single variable or factor can explain how faculty actually teach in the classroom. Instead, a variety of factors such as individual characteristics, institutional culture, and local organizational factors all dynamically interact to shape how teachers plan and then teach their courses (Hativa and Goodyear 2001; Stark 2000).

Discerning with more precision the types of experiences and knowledge that faculty actually draw upon when teaching and moving beyond the meme that faculty "teach the way they were taught" will not only contribute to the field of higher education's basic knowledge about faculty identity and work, but also promises to provide important insights into educational reform. Encouraging faculty to adopt teaching practices that are grounded in evidence about how people learn is a current policy priority in the United States, particularly in the economically vital science, technology, engineering, and mathematics (STEM) disciplines. However, the adoption of inquiry-based teaching methods appears to be slow and spotty (President's Council of Advisors on Science and Technology 2012). Thus, a critical research problem facing the field is to understand why faculty "fail to use demonstrably effective teaching methods and other data-based information about teaching" (Menges 2000, p. 7). We contend that faculty members' modeling of their own mentors' teaching is but one factor that may explain the persistence of the lecture method and that the provision of new skills and information about pedagogy, while important, is not a panacea that will transform postsecondary teaching and learning. This is largely due to the fact that teaching practice is influenced by a multiplicity of factors, and evidence suggests that some education reforms fail to take root because of overly top-down approaches that ignore the existing knowledge and expertise of faculty (Henderson and Dancy 2008). Instead, educational reforms are most effective when supportive of teachers' growth as professional educators while also respecting their existing knowledge and skills (Darling-Hammond and McLaughlin 1995; Fishman 2005).

In this paper, we analyze interviews with 53 STEM faculty from three public research universities in the US that focused on the primary factors that influenced their teaching, finding that faculty reported four distinct types of influences: experiences as a student, as a

[1] By *faculty*, we mean all people who hold undergraduate teaching positions—whether full- or part-time, tenured or untenured—in postsecondary institutions. Throughout this paper we use the terms "faculty" and "instructor" interchangeably.

teacher, as a researcher, and from their personal lives. Then, based on in-depth analyses of how two instructors actually planned and taught their classes, we demonstrate how these experiences interact with other factors in a non-linear fashion to influence teaching. These findings suggest that the field of higher education should retire the phrase "teach the way they were taught" and instead begin to acknowledge and appreciate the rich and varied sources of knowledge that informs faculty instructional practice and professional identities.

Background

The influence of preexisting knowledge systems in shaping cognition, behavior, and identity is widely recognized in cognitive psychology and education research, with much of the seminal research in this area focusing on learning and development. Based on decades of research in the learning sciences, people construct new understandings based largely on what they already know (Bransford et al. 1999). One of the primary sources of these associations and knowledge structures is through direct experience with the world. In particular, through observations of other people's behavior, a learner begins to develop a storehouse of knowledge regarding how to perform particular tasks. Bandura's (1977) social learning theory of development emphasizes the important role that the observation of others' behavior plays in this process of shaping an individual's knowledge structures and actions. The importance of observation is echoed in research on apprenticeship, which emphasizes not only modeling behavior but also the important role that immersion in specific sociocultural environments plays in learning (Lave 1988).

These ideas regarding learning and development are particularly salient to education, given evidence that preexisting knowledge systems can inform a variety of instructional behaviors such as the selection of pedagogical techniques and the interpretation of subject matter (Schoenfeld 2000). Further, these knowledge systems form the foundations upon which teachers' identities as professional educators are built and develop over time (Beijaard et al. 2004). These identities are shaped by a variety of forces including the influence of mentors, immediate family influences, knowledge of pedagogy and the subject matter, and one's practical knowledge gained in the classroom (Sugrue 1997). Importantly, these pedagogical knowledge and belief systems are shaped before teachers enter the classroom as instructors. Students entering pre-service teacher training programs bring a host of beliefs and assumptions regarding teaching and learning to bear upon their nascent professional practice (Ball 1996). Lortie (1975) posited that these beliefs begin to accrue during an individual's time as a student, which acts as a preliminary training phase or an "apprenticeship of observation." However, students do not consciously and methodically study and mimic their own instructors; rather, they rely on an implicit recall of episodic memories that provide an accessible repertoire of behaviors in the classroom (Nespor 1987).

In addition, one of the most important factors shaping teacher knowledge and growth is on-the-job training and experience. Through experimenting with different pedagogical techniques in the classroom, teachers amass a catalogue of knowledge about what works and what does not work. This type of learning is also known as experiential learning (Kolb 1984), and some characterize the type of knowledge gained from such experiences as craft knowledge that comes with the wisdom of practice (Shulman 1987). Grounded in Aristotle's notion of "phronesis", or the practical wisdom that comes from applying general principles or ideas to specific idiosyncratic situations, this type of knowledge is particularly

important for educational practice where educators are faced with unique situations and students on a regular basis (Halverson 2004).

A significant body of literature exists that examines facets of faculty growth and development, such as socialization to the academic profession (Tierney and Rhoads 1993) and the development of early career academic identities (McAlpine and Amundsen 2009; Austin 2002). However, little empirical work exists on how faculty acquire knowledge and experience in their roles as teachers and to what degree these repertoires of pedagogical approaches influence classroom practice. In one of the few studies on this topic, Hativa (1997) surveyed faculty on how they learned to teach, finding that trial-and-error teaching in the classroom, self-reflection, and student feedback each influenced faculty practice. Hativa also revealed that the observation of mentors was not particularly influential in shaping respondents' understanding about teaching. In spite of this evidence, a widely held assumption persists that because most faculty were not given formal training in pedagogical methods, they simply mimic the types of instruction they observed as students (e.g., Halpern and Hakel 2003; Mazur 2009). In any case, the phrase "faculty teach the way they were taught" has become an unexamined maxim in higher education research and practice.

Methods

For this study, we use a qualitative case study design to conduct an in-depth analysis of instructional decision making and practice within three large, public research universities (Yin 2008). The case reported in this paper focuses on 53 math and science instructors who taught undergraduate courses in the spring of 2010. We selected the study locations based on their similarities in the size of their undergraduate populations and the number of pedagogical reform initiatives in math and science underway at the time of data collection. The sampling frame for this study included 263 individuals listed in the Spring 2010 timetable as the instructor of record for undergraduate courses in math, physics, chemistry, biology, and geology departments. These disciplines were included in the analysis due to the focus on STEM education for the larger project upon which this study is based.[2] Individuals were contacted up to two times via email for participation in the study, and the final study sample included 57 faculty (22 % of the initial sample frame). For the analysis reported in this paper, we focus on a sub-set of these participants who elaborated on prior experiences that shaped their instructional practices, which resulted in a final sample of 53 individuals.[3] For information about the study sample see Table 1.

We then selected two faculty from this group for in-depth analyses that included both interview and classroom observation data in order to examine instructional decision making in practice. The two individuals were selected based on the degree of detail and specificity with which they described the relationship among their experience, knowledge, and their current teaching. Limitations to the study include the self-selection of respondents into the study sample and the lack of data regarding the tacit or subconscious thoughts of participants, such that an important facet of cognitive activity is necessarily overlooked.

[2] While the disciplinary context of instruction is an important factor that influences teaching (e.g., Lindblom- Ylänne et al. 2006), due to space limitations we do not focus on this topic in this paper.

[3] Thus, four respondents did not provide sufficiently detailed responses about this topic to merit inclusion in the study sample.

Table 1 Description of sample

	n	Percentage
Sex		
Female	20	38
Male	33	62
Discipline		
Math	15	28
Physics	11	21
Chemistry	9	17
Biology	10	19
Earth/space science	8	15
Level of course		
Lower division	36	68
Upper division	17	32
Size of course		
50 or less	10	19
51–100	16	30
101–150	8	15
151 or more	19	36
Position type		
Lecturer/instructor (non tenure-track)	26	49
Assistant Professor	5	9
Associate Professor	4	8
Professor	18	34

Data collection

The data reported in this paper include interviews with the entire study sample and classroom observations with each of the two respondents selected for the in-depth analyses.[4] A team of three researchers (i.e., the second author and two graduate assistants) conducted all data collection activities.

Interviews

The interviews took approximately 30–45 min to conduct. The semi-structured interview protocol consisted of 17 open-ended questions focused on key decision points that shaped the curriculum, selection of specific teaching methods, and class content. The key question in the interview salient to this study focused on how or why respondents selected particular techniques for use in their classroom. In response, many respondents cited their past experience and their knowledge base regarding teaching and learning. In addition, an open-ended introductory question also elicited important information about the types of factors that shaped their approach to teaching.

[4] Interviews and classroom observations were conducted with all respondents in the study, but observation data are reported for only two individuals.

Classroom observations

The rationale for including classroom observation data for the two in-depth analyses was to explore the relationship between experience and knowledge and classroom teaching practices. As part of a larger study, the Teaching Dimensions Observation Protocol (TDOP) was developed. The TDOP included three categories of codes (i.e., teaching methods, cognitive engagement, and instructional technology). The teaching methods category refers to overt and observable pedagogical techniques (e.g., lecturing, small-group work, types of questions posed to students). The cognitive engagement category refers to the types of cognitive activity that students may potentially experience in the classroom. Finally, the instructional technology dimension refers to instructional materials or technologies used by the instructor. Prior to data collection, the three researchers participated in an extensive three-day training process. In order to establish inter-rater reliability, the analysts coded three videoed undergraduate classes (two in chemistry and one in mathematics). For detailed information about the protocol see Hora and Ferrare (2013).

Data analysis

The data for this study were analyzed in two stages: (1) inductive analysis of all transcripts to identify types of knowledge and experience, and (2) in-depth analyses of two instructors using the thematic network analysis technique.

Stage 1: Identifying types of knowledge and experience

Interviews were transcribed and entered into NVivo® qualitative analysis software. An inductively derived coding scheme identified text related to instructors' experiences and knowledge regarding their teaching practices. Once identified, the two authors took all text fragments coded as types of experiences and knowledge and analyzed them using techniques from grounded theory (Glaser and Strauss 1967). After creating the initial code list, the analysts met to discuss the coding scheme and then created a final code list that included four types of experiences such as "experience as a teacher" and "experience as a researcher." During this analysis, both authors met frequently to discuss emerging themes and patterns in the data.

Stage 2: In-depth analyses of two instructors' practice

The technique used to conduct the analyses of instructional practice is based on a structured approach to grounded theory where a pre-determined theoretical framework (i.e., a cognitive view of instructional decision making) was used in combination with the inductive analysis of text (Corbin and Strauss 2007). That is, the interview transcripts were analyzed to identify statements where respondents explicitly described how specific cognitive characteristics (e.g., types of prior experiences and knowledge) influenced their class planning and practice. Once these statements were identified, an inductive analysis of the text was conducted using the thematic network analysis method, which is an approach for identifying relationships between concepts or events in a graphic and time-ordered fashion (Miles and Huberman 1994). Finally, we analyzed TDOP data for each instructor and report how many times particular codes were observed as a proportion of all observed codes.

Results

In this section we report the results from this study: types of experiences that faculty report as being influential to their teaching and how these experiences shaped the actual planning and teaching practices of two individual instructors.

Types of past experiences

Analysis of the data revealed four types of prior experiences that respondents consciously drew upon when considering their teaching practice. The four main types of prior experiences pertain to the role of the respondent when they acquired the pertinent knowledge. The four types and their subcategories are detailed in Table 2.

As an instructor

Forty-six respondents reported that their experiences as instructors informed their knowledge base for teaching. These experiences include previous experience in the classroom, reflection on formal and informal evaluations, professional development, and interactions with other instructors.

Prior classroom experience

Forty-two respondents reported that their experiences in the classroom, some of which took place graduate school or post-doctoral positions, influenced their current teaching practice. Through these experiences, faculty reported developing a rich body of knowledge regarding what worked (and did not work) in the classroom for particular subjects and student types. In particular, several respondents reported that in-class experimentation or trial-and-error provided a major source of insight into teaching and learning. Trial-and-error applies to both methods of teaching (e.g., trying clickers) and content (e.g., knowing what topics "trip students up" and reacting appropriately). Respondents paid attention to particular cues presented by their students after introducing new pedagogical techniques, such as noticing that students only write down what they write or that students remember the "human side" of the material better. In other instances, a long period of time in the classroom translated into a lack of interest in pedagogical change. For example, one geology instructor claimed he did not seek advice or input about his teaching from others because, "Most of these courses that I teach now I've been teaching more than 20 years…. and so I'm not in the mode of creating a new course or developing them any further."

Professional development

Eighteen respondents reported that various forms of professional development activities had strongly informed their knowledge base for teaching. These professional development activities included workshops, research groups, individualized feedback (e.g., having their teaching video-taped and analyzed by faculty development professionals), or reading pedagogical research.

Table 2 Description and frequency of types of experiences informing teaching practice (n = 53)

Type of experience	Frequency	Description
As an instructor	**46**	**Overall references to experiences as an instructor**
Prior classroom experience	42	Experiences from previous teaching experiences including trial-and-error in the classroom, and monitoring student outcomes/reactions to teaching
Professional development	18	Participation in workshops, seminars, and trainings
Reflections on feedback	11	Reflections on informal and formal feedback about teaching performance
Interactions with other instructors	7	Interactions with colleagues regarding teaching
As a student	**22**	**Overall references to experiences as a student**
How respondent learned	14	Ways that respondent learned (or not) as a student
How respondent was taught	12	Modeling ways that respondents' mentors or teachers taught
In non-academic roles	**10**	**Overall references to experiences outside of academia**
As a researcher	**9**	**Overall references to experiences as a researcher**

Reflections on feedback

Eleven instructors reported that formal and informal evaluations of their teaching abilities provided information that upon reflection directly shaped how they made instructional decisions. Specifically, student evaluations were an influential catalyst for either validating existing practice or for fomenting change in the case of negative reviews. For example, a biology instructor who was comfortable with his reviews said that those evaluations, "tell me that I don't really need to drastically alter my style." In this case, evaluations reinforced his view that his knowledge base and instructional approach was sufficient and effective. In another case, a math instructor said, "It's very important what [the evaluations] say…And I adjust depending on what they say."

Interactions with other instructors

Seven respondents cited interactions with other instructors, either through informal conversations or classroom observations that granted them the opportunity to "borrow" perceived good practices, as being influential in their own teaching. For example, one biology faculty reported, "I'm shameless about borrowing what I think are good ideas." Importantly, these interactions are not limited to instructors' home academic units, but also include the influence of colleagues across campus, in disciplinary societies, and in other communities of practice (e.g., discipline-based education researchers).

As a student

Another role that respondents discussed in relation to the development of their knowledge about teaching and learning was that of a student (22 respondents).

How they learned

Fourteen respondents reported that they had strong memories of how they best learned as students, and that these memories constituted a repertoire of knowledge about teaching that they actively drew upon. One chemistry instructor said, "I benefited from repetition when I was a student, and so the important concepts from previous lectures I'll always try to repeat." Respondents also remembered their reactions to certain material and drew upon that knowledge when teaching, especially those topics that they found confusing. Sometimes, instructors vaguely recalled memories of their own learning that influenced their teaching, such as a chemistry instructor who said, "I haven't done a whole lot of learning about how people learn, so what I know about is what I learned."

How they were taught

Twelve respondents reflected on the pedagogical techniques that their own teachers used as a primary source of their own teaching-related knowledge. For example, one physics instructor found that as a student he fell asleep during his class if the notes were presented beforehand and then read aloud in class. As a result, he primarily used clickers and examples in his current classes to keep students engaged and alert. Another respondent reflected, "I had wonderful teachers who challenged me to be the best that I can be, and so in the same way I try to challenge my students." These data support the idea that faculty do indeed "teach the way they were taught."

Non-academic roles

Ten respondents reported that non-academic experiences played an important role in shaping their knowledge base for teaching. Instructors frequently cited familial relationships as influential, with instructors either consulting significant others or noting how their children shaped their interactions with students. Two respondents mentioned running ideas past their spouses who were also instructors. In other cases, interactions with family influenced how respondents thought about their disciplines and their instructional approaches. For example, one respondent noted how using analogies in class came from imagining how to explain the material to her niece. Respondents also reported that involvement in activities outside of academia, such as tutoring high school students or rock climbing, influenced how they thought about teaching and learning.

As a researcher

Nine respondents reported that their experiences as researchers had played a significant role in their development as a teacher. In some cases, respondents made a point to teach students techniques that they used in their own research programs because they reflected how people "actually do science" and thus were an effective pedagogical tool. For others, one of the benefits of attending a research university was to be exposed to cutting-edge research activities, and the classroom was viewed as a good venue for providing students with a glimpse into the world of academic research. In these ways, respondents' identities and activities as researchers play an important role in their selection of pedagogical techniques and classroom activities.

In-depth analyses of instructional decision making and classroom teaching

In this section we report the results from in-depth analyses of the instructional decision-making processes and subsequent teaching practices of two instructors.

Example 1: Dr. Paulson

At the time of data collection, Dr. Paulson was a professor teaching a lower division advanced general chemistry course. Dr. Paulson reported that a variety of factors had influenced his identity as a postsecondary teacher in general, and how he planned and taught his courses in particular. First, he stated that his experiences as an instructor had provided him with a wealth of knowledge about what constitutes effective instruction. With over 40 years of experience in the classroom, he felt that he had discovered that a key to helping students comprehend and retain the course material was to engage them in the classroom. This emphasis on maintaining students' attention was grounded in the belief that learning requires sustained attention and engagement. As he stated, "I find if I keep them interested, they'll learn." Dr. Paulson stated that he had found over time that student attention can be obtained through the use of stories and visual aids (e.g., demonstrations and movies), which he felt were effective because they brought abstract principles of chemistry into a more accessible form. Thus, a combination of personal beliefs about learning and decades of trial-and-error in the classroom coalesced to shape his current instructional style.

Second, his approach to teaching was also informed by his experiences in the lab as a researcher. Due to his research experience, where he regularly observed how scientific

knowledge was used in practice (i.e., in a creative, experimental fashion that required an integrated set of information to address authentic problems), he felt that providing students with "random pieces of information" with no connection to real-world phenomenon did not make sense to him in terms of classroom teaching. Third, Dr. Paulson's life outside of academia acted as a particularly strong influence on how he taught his courses. After an accident that impacted his fine-motor skills and which led to a regular quiver in his hands, writing on a chalkboard or transparencies was no longer a tenable option. Importantly, contextual factors such as a highly structured curriculum that afforded little autonomy in terms of selecting content also influenced his decisions about teaching.

Next, we observed one of Dr. Paulson's classes and, while no causal relationship between his previous experiences and his classroom behaviors can be ascertained from the data, the analysis does provide a starting point for a discussion regarding the dynamics between thought and action (Kane et al. 2002). In the observed class, the teaching methods that Dr. Paulson used included lecturing (observed in 90 % of all observed 5-minute intervals[5]), while also using the overhead projector with transparences (90 %). He also showed slides from his laptop (25 %), performed demonstrations (25 %), and provided verbal illustrations or anecdotes (10 %). Thus, Dr. Paulson primarily lectured with visual aids, while intermittently using demonstrations and telling stories to his students. Recall that Dr. Paulson's prior experiences as a teacher had led him to believe that engaging his students was a critical factor in their learning and in his interview had explicitly linked this view to his use of stories and visual aids. Regardless of these goals, lecturing was still the dominant mode of instruction, which suggests that more tacit views of teaching and/or habituated practices may guide Dr. Paulson's teaching more than his self-reported decision-making steps articulated in the interview.

Example 2: Dr. Christensen

Dr. Christensen was a lecturer teaching an upper level matrix algebra class that was part of a math sequence at a large, public research institution. While discussing the factors that shaped her own teaching practice, Dr. Christensen referred to her experiences as an instructor, researcher, and a student. Like Dr. Paulson, Dr. Christensen attributed much of her current teaching style to her previous experiences in the classroom as a graduate student and now as a full-time lecturer. She described how her teaching had developed over time, an evolution characterized by a growing understanding of student problem areas as well as a process of doing "what felt comfortable to me." Despite receiving formal pedagogical training upon beginning her teaching career, she found the approaches advocated by the course's instructors to be unsuitable to her particular style, which was largely working on examples at the blackboard. This technique, which she called "structured discussion," was designed to get students involved in the class and to confront their own misconceptions, since she also asked them to come up and work at the chalkboard. For the observed class, she indicated that she would work through example problems with students at the board. Specifically, Dr. Christensen remembered students' difficulty with vector space when she last taught the class and therefore tried to emphasize it in her current class. Dr. Christensen's classroom presence has also been affected by student evaluations, which indicated some ineffective mannerisms (e.g., talking while writing on the chalkboard) that she remedied.

[5] For each 50-min class period a total of 10 intervals were observed.

Besides her experience as an instructor, Dr. Christensen's involvement in research influenced her teaching both in terms of content and teaching strategies. When discussing content related to her area of research, she found herself wanting to explain the "beauty" of mathematical theory to inspire her students. However, a fixed syllabus and subsequent time constraints prevented her from delving very deeply into issues she saw as important. While unable to give as much detail concerning her research as she would have liked, Dr. Christensen drew upon her own approach to mathematical research as a framework for her own teaching. For example, when she introduced more difficult problems she gave her students "time to digest" or time to think about the problems she presented in order to understand them. This slow, methodical approach to working through problems was based on how she approached her own work. Finally, Dr. Christensen discussed the role of her experiences as a student as another influence on her teaching practice. Instead of modeling the behaviors of her own teachers or mentors, she reported drawing upon her own experience as a learner when deciding how to teach. For example, she noted that when she took classes that taught material from abstract to specific levels, it did not make sense to her. Thus, she taught students first by discussing specific cases and then moving on to the abstract idea or proof underlying the case.

During the observed class, Dr. Christensen primarily worked through problems (70 % of the 5-min intervals) at the chalkboard, while occasionally pausing to elaborate on key points. She used the chalkboard in almost every interval (95 %), and she asked a variety of questions (40 %), and through this process identified a topic that students were having difficulty grasping (i.e., geometric dimensions). Based on this observed class, Dr. Christensen's preferred teaching approach of working at the chalkboard with intermittent opportunities for student board work was not observed. However, her personal preference to primarily work through problems during class, which was based on her own personal preferences for teaching, was confirmed. Further, the intention of the structured discussion approach to surface student misconceptions through board work was observed, just in a different form (i.e., question-and-answer sessions). Thus, it appears that Dr. Christensen's teaching approach, which had evolved over time through a combination of personal preference, classroom experiences, and a growing understanding of student learning, all combined to shape her classroom teaching.

Discussion

In this paper we presented evidence regarding the types of past experiences that faculty report as playing an influential role in shaping their knowledge base for teaching. In this section we discuss key findings from the study and implications for instructional improvement in undergraduate education.

Faculty knowledge about teaching is shaped by a variety of experiences—not just modeling

This study was motivated by the desire to examine if the oft-cited truism that "faculty teach the way they were taught"—that is, through imitating and modeling the practices of their mentors—was borne out by evidence from an empirical study of faculty decision making. The evidence shows that instructional decision making is far more complex than this phrase suggests, and that modeling and imitation of one's own teachers is not the only

type of experience that shapes faculty teaching practice. We highlight two additional types of experiences that faculty report as being particularly influential for further discussion.

Previous experience in the classroom

The data reported in this paper indicate that time spent in the classroom as an instructor is an influential source of knowledge about teaching, which is consistent with prior research that highlighted the role of experiential learning in the professional growth of K–12 teachers (Lortie 1975; Shulman 1986) and postsecondary faculty (Hativa 1997). Indeed, our data reveal that instead of blindly modeling the behaviors of their previous mentors or instructors, faculty often draw upon their own experiences in the classroom regarding what teaching activities work, commonly encountered student misconceptions, and so on. Thus, the repertoire of teaching practices that faculty draw upon is largely developed through their own experiences in the classroom. This account is also similar to the idea of practical wisdom or craft knowledge. Besides being developed unconsciously over time, this type of knowledge can also be carefully cultivated through the deliberate testing of new techniques in the classroom and reflection upon their efficacy in improving student learning, which was an approach reported by some faculty in the study sample.

Of course, the data do not uniformly reveal a willingness of faculty to continuously learn and revise their teaching behaviors based upon evidence of ineffectiveness. For some, years of experience in the classroom has resulted in a recipe for instruction that is satisfactory and does not require any adjustment. The stable and potentially rigid nature of an instructor's knowledge base is supported by research indicating that changes to an individual's belief systems and/or behaviors are difficult in adulthood (Pajares 1992). For faculty such as Dr. Christensen, attempts to change teaching behaviors may be productively viewed as a problem of first acknowledging an individual's existing knowledge and beliefs, and then providing new information such that the previous knowledge can accommodate new insights and perspectives (Piaget 1975). This suggests that for those faculty who see no need for altering their teaching practice, educators should first demonstrate the value of new approaches in relation to the existing practices and craft knowledge of faculty.

Previous experiences as learners

Another important source of knowledge that faculty draw upon when planning and teaching their courses is based on their experiences as learners, but not only in terms of imitating their own previous instructors' behaviors. While several faculty in this study reported that they did in fact learn about teaching by observing and then imitating their instructors, many also reported that these experiences in the classroom were more influential in terms of how they did (or did not) learn the material. In some cases, such as the previously mentioned instructor who often repeats topics in his classes since he learned from repetition as a student, this amounts to a projection of sorts from one's own style of learning to an entire group of students. That is, the teacher assumes that his or her students will learn the same way that they did when they were students. This finding underscores the important influence of study habits and approaches to learning acquired in one's formative years as a student, and how these early skills can be mobilized when crafting learning experiences for others.

Another implication of the finding that faculty experiences as learners exerts a considerable influence on their teaching is that the learning process does not cease at the

completion of graduate school, and thus faculty will continue to learn about themselves, their discipline, and students throughout their careers. The lessons and insights gleaned from these learning experiences may in turn contribute to their pedagogical toolkit, some consciously and others unconsciously. Thus, how faculty approach teaching and learning is strongly influenced by their experiences as learners throughout the life course, where specific teaching (and study) habits are adopted along with more subtle ways of thinking and acting.

The disciplinary context of faculty socialization and instructional practice

The results reported in this paper should also be interpreted in light of the disciplinary context in which the participants developed their professional identities, and in which they conduct their daily work. This is important for two reasons. First, in academia the discipline is the primary cultural unit, where students are introduced to a unique set of values, codes of conduct, and epistemological views (Becher and Trowler 2001; Välimaa 1998). Thus, the pool of experiences that faculty appear to draw upon when planning and teaching their courses are grounded in a specific cultural context that imprints upon individual students and faculty a particular way of thinking about teaching and learning (Bourdieu 1988). For example, Dr. Paulson's conviction about the merits of student engagement and visual aids should be considered in light of his long career as a chemist. Second, the daily tasks and routines that comprise academic work are themselves deeply shaped by disciplinary groups (Clark 1986), such as the selection and sequencing of knowledge in the curriculum (Stark 2000). For Dr. Christensen, this includes the taken-for-granted practice of working out problems at the chalkboard, which is a core cultural practice among many mathematics teachers (Hora and Holden 2013). Thus, the repertoire of instructional practices that faculty draw upon is the result of a socialization process into a unique cultural group, a process that is not dissimilar to an individual's socialization into any social group.

The complexities of instructional decision making

Finally, we highlight the fact that instructional decision making is not a simple, linear process where a single factor (e.g., a mentor's teaching style) can be causally linked to an individual's behavior. Instead, a complex combination of cognitive, sociocultural, and organizational factors interact in particular situations to influence teaching behaviors (e.g., Borko et al. 2008). This oversimplification is also evident in the "teach the way they were taught" formulation, where faculty are viewed through a deficit model of simply lacking the appropriate knowledge about teaching and learning. Instead, the data presented in this and other papers (see also Hora and Ferrare 2013) represent an initial attempt at articulating the specific mechanisms that constitute the planning process and the factors that impinge upon instructional decision making along the way.

Implications and conclusions

These results have implications for the work of policymakers and instructional designers engaged in pedagogical improvement and faculty development. One of the dominant approaches to improving teaching at the postsecondary level is to expose faculty to bodies of literature with which they likely have had little prior experience—that of cognitive

psychology and educational research. A basic idea about how people learn is that students come into any instructional situation with preconceptions about a topic that must be elicited and engaged so that they can effectively comprehend and internalize new information (Bransford et al. 1999). Based on this principle of learning, Halpern and Hakel (2003) argue that faculty should "assess learner knowledge and understanding at the start of every instructional encounter, probing for often-unstated underlying assumptions and beliefs that may influence the knowledge, skills, and abilities that we want students to acquire" (p. 39). But this idea also applies to adult learners, suggesting that faculty developers should adopt a similar approach to the faculty who come to their workshops, brown bag talks, and seminars (Merriam et al. 2012). In making the assumption that faculty have little to no prior knowledge about teaching, and that their knowledge base is composed exclusively of how they were taught, some may ignore this fundamental idea about learning. Instead, the existing skill sets, craft knowledge, and instructional challenges facing faculty in specific situations should be the foundation upon which professional development activities are built (Putnam and Borko 2000), instead of adopting the not uncommon view that teachers are half-full vessels that need to be filled with the knowledge of outside experts (Darling-Hammond 1999; Halpern and Hakel 2003).

Several directions for future research on the role of faculty knowledge in shaping instructional decisions are suggested by the results of this study. Given that this study focused primarily on science and mathematics faculty, therefore capturing a very distinct group of faculty and teaching practices, future research could focus on other disciplines to determine their similarities or differences to the findings of this study. In addition, exploring the role of different types of prior experience in terms of identity formation could also be a productive line of inquiry. Finally, the recognition that much of cognitive activity operates on an automatic or subconscious level suggests that research on faculty work should begin to account for the influence of tacit knowledge. As the field of higher education gains more insights into the origins of faculty knowledge, faculty will hopefully be viewed as professionals who would benefit not only from formal training in educational theory, but whose knowledge about teaching and learning represents a rich body of practical experience that can be acknowledged and built upon.

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